Scleral Lenses 101
~the basics and beyond

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Overview

• Clinical Indications
• Advantages and Challenges
• Terminology
• Anterior eye anatomy
• Basic Design Features
• Instrumentation
• Fitting basics – lens selection, fitting, evaluation, follow-up
• Tips and Troubleshooting

Clinical Indications

• Vision Improvement
  – Correcting the irregular cornea
  • Corneal Ectasia
    – Primary – Keratoconus, Keratoglobus, Pellucid marginal degeneration (INTACS, CXL)
    – Secondary – post-refractive surgery, corneal trauma
  • Cornea Transplant
  • Corneal Degenerations
  – Normal Cornea
  • Presbyopia, moderate to high corneal astigmatism

Clinical Indications

• Ocular Surface Protection
  – Dry Eye
  – Incomplete lid closure
  – Sjorgen’s Syndrome
  – Stevens-Johnson Syndrome
  – RCE / corneal abrasions
  – Graft host disease
  – Infiltrative keratitis

Persistently-off CXL (16 year old male)

– Constant epithelial defect for 2 months
• Neomycin/dexamethasone, Zirgan, Oflaxacin, doxycycline, acyclovir, AT, BCL
– Applied a scleral contact (15.6 diameter)
• Wore extended wear for 6 days
• Cont Maxitrol and oflaxacin drops
– Lens removed after 6 days of wear
• epithelial defect healed
• overlying corneal haze

Corneal Abrasion

• Healing response attributed:
  – Oxygenation
  – Moisture
    • Constant tear film
  – Protection of the corneal epithelium
  – Minimal abrasion
• Allows epithelium to migrate, adhere, and proliferate over the persistent epithelial defect.
Clinical Indications

- Cosmetic/Sports
  - Hand-painted scleral lenses
  - Ptosis
  - Water sports
- Lens failure in other designs

Advantages of Scleral GPs vs Corneal GP

- Centration
  - Fitting a “regular” part of the eye
- Lens Retention
  - Minimal chance of inferior standoff
- Comfort
  - Reduced lid interaction; no corneal interaction
- Vision
  - Masking severe corneal irregularity

Challenges associated with scleral lenses

- Handling
  - Difficult I and R (initially)
  - Apprehensive patients
- Fitting
  - Subtle fit indications
  - Increased chair time
- Physiology
  - Dk/A – Oxygen must diffuse over great distance
  - Long-term effects of scleral lens wear are unknown

Terminology

- Classification
  - Corneo-scleral 12.9mm to 13.5mm
  - Semi-Scleral 13.6 mm to 14.9mm
  - Mini-Scleral 15.0mm to 18.00mm
  - Full-Scleral 18.1mm to 24+

Anatomy and Shape of the Anterior Ocular Surface

- Maximum scleral lens size for normal eye: 24mm
- Scleral Shape Study

Assuming 12mm cornea diameter – maximum physical diameter of a scleral lens ~24 mm
Anatomy and Shape of the Anterior Ocular Surface

• Corneal Toricity does not typically extend to sclera

• The ocular surface beyond the cornea is nonrotationally symmetrical
  – Asymmetrical
  – The entire nasal portion typically flatter compared to the rest

Anatomy and Shape of the Anterior Ocular Surface

• Clinical Consequences
  – Temporal-Inferior decentration of scleral lenses
    • Inferior decentration
      – Weight/gravity
      – Eyelid pressure
    • Temporal
      – Flatter nasal elevation
  • Conjunctival Prolapse

Basic Design Features

• Spherical Design
  • Concentric symmetrical (spherical) scleral lens
  • Non-toric back surface

  – Optic Zone
    • Centermost zone
    • Optics/Lens power
      – Anterior surface
    • Back surface
      – Ideally mimics corneal shape
    • Completely vaults cornea

Basic Design Features

• Spherical Design
  • Concentric symmetrical (spherical) scleral lens
  • Non-toric back surface

  – Transition Zone
    • Mid-periphery or limbal zone
    • Creates the sagittal height
    • Can be reserve geometry
    • Completely vaults limbus

Basic Design Features

• Spherical Design
  • Concentric symmetrical (spherical) scleral lens
  • Non-toric back surface

  – Landing Zone
    • Area of the lens that rests on anterior ocular surface
    • Scleral zone or haptic
    • Alignment to provide even pressure distribution is key

Example Parameters:

BC: 7.50
PC1: 7.85 (if reverse geometry 6.89)
PC2: 9.00
PC3: 12.25
PC4: 14.00
Basic Design Features

• Toric Lens Designs
  – Front Surface Toric -
    • Anterior surface front toric optics to improve vision
    • Located on the front surface of the central optical zone
    • Indicated when residual cylinder over-refraction is found
    • Needs stabilization
      – Dynamic stabilization zones or prism ballast
      – LARS

• Toric Lens Designs
  – Back Toric Haptics
    • Landing zone is made toric to improve lens fit
    • Does not interfere with central zone of scleral lens
    • Better ocular health
      – Fewer areas of localized pressure
      – Decreased bubble formation
      – Longer wearing time and better patient comfort
    • More frequently needed in larger diameter sclerals

• Toric Lens Designs
  – Bitoric both anterior optics and back toric haptics
    • Front surface toric optical power
    • Back surface toric periphery
    • No need for lens stabilization

• Multifocal Scleral lens design
  – Simultaneous Multifocal Lens Design
    • Aspheric or concentric
    • Center Near and Center Distance Designs
      – Can adjust near powers
      – Can adjust zone size
    • Not all scleral lens designs have a MF option

Multifocal Scleral lens design
  – Center of cornea
  – OD
  – Visual axis
  – Lens
  – Near zone

Basic Design Features

- Lens Material
  - High(est) Dk lens material; plasma or hydra-PEG
    - Considerably thicker when compared to corneal GP
    - 250 microns to 500 microns
  - Optimum Extreme, Menicon Z

- Increasing Oxygen transmissibility
  - 1. high Dk material (Dk > 125)
  - 2. minimal tear clearance behind the lens (<200)
  - 3. Reduced center thickness of the lens (<.250)

Fitting Basics

- Hydra-PEG
  - Polyethylene glycol (PEG) – base polymer
    - Covalently bonded to the lens surface
    - Creates a wetting ocular surface, increases surface wettability, increases lubricity, decreases protein and lipid deposits, improves TBUT.

Fitting Basics

- Completely vault the cornea and limbus while aligning to the bulbar conjunctiva

Fitting Basics

- 1. Diameter
- 2. Clearance
- 3. Landing Zone Fit
- 4. Lens Edge
- 5. Asymmetrical Back Surface Design
  - Some trial sets are toric back surface
- 6. Lens Power

Fitting Basics

- How can I vault a steep cornea with a flat lens?
  - BC much flatter than “K”
  - Very steep cornea

Fitting Basics

- 1. Diameter
  - Choose a Fitting Set
    - Direct vs Indirect control
  - Laboratory warranty/exchange policy
  - Overall Diameter
    - Larger – more clearance needed, ectasias
    - Smaller – easier to handle, less clearance
Fitting Basics

• 1. Diameter
  - HVID
    • <12mm
      - Start with a 16.0 mm or smaller lens
    • >12mm
      - Start with a 16.0 mm or larger lens
  - Diameter of the optical zone and the transition zone chosen roughly 0.2mm larger than the corneal diameter

Fitting Basics

• 2. Clearance
  - Minimum of ~100 microns
  - Typically aim for 200-300 microns after settling
  - Maximum of 600 (if desired)
  - Base Curve Determination
    • Select an initial base curve that is flatter than the flat k value
    • Use 14 mm chord OCT, measure sagittal depth

Fitting Basics

• Evaluate overall corneal chamber appearance
  - Diffuse beam, low mag, medium illumination
  - Observe centration, areas of bearing, tear lens appearance, look for bubbles

Fitting Basics

• Evaluate central clearance
  - Compare lens thickness to tear lens thickness and estimate central clearance in microns

Fitting Basics

Look for continuity of the tear lens...

Acceptable clearance: Too little clearance:
Fitting Basics

- Look for continuity of the tear lens…

Fitting Basics

- Evaluate the Limbal Clearance…

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Fitting Basics

- Change lens base curve/sagittal depth until desired central clearance is reached
  - Considerations:
    - All scleral lenses will settle over a period of hours
    - Expect ~90 to 150 microns settling
    - Aim for 150 to 300 microns after settling
    - Build-in settling time into fitting session ~30 min

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Fitting Basics

- UMSL Study:
  - No significant settling after 4 hours of wear
  - Most settling within the 1st hour
  - Large Diameter Scleral settle ~90 microns, slower
  - Mini Scleral ~130 microns, faster

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Fitting Basics

- Evaluate remaining corneal chamber
  - Optic Section
  - Sweep limbus to limbus noting tear lens thickness
  - Looking for tears in optic section beyond the limbus and should increase in thickness toward the central cornea

**Adequate limbal clearance is critical for an acceptable fit and good tear exchange**
Fitting Basics

• Anterior Segment OCT

Fitting Basics

• 3/4. Landing Zone Fit/Edge
  – Bulbar conjunctival vessels
  – Look for blanching
    • Inappropriate scleral curve alignment
    • Typically indicates PC is too tight
    • Or new toric back surface haptics
  – Confirm no lens movement
  – Perform all peripheral lens evaluations in Primary Gaze.

• Ideal alignment when vessels course unobstructed under the scleral curves
Fitting Basics

5. Asymmetrical Back Surface Design
   - Allows for more equal pressure distribution
   - Can help center a inferiorly decentered lens
   - Flat and steep meridian
     • Can adjust either independently
     • Flat meridian is typically marked
     • Will lock into place

6. Lens Power/Over-Refraction
   - Expect close to spherical OR
   - If OR yields significant cylinder check - flexure
     • Do over-keratometry or over-topography
   - Residual Cylinder
     • Front surface toric
     • Usually has a great visual outcome

Fitting Basics

Design and Order
   - Often lens modifications will need to be made from the best trial lens fit
   - Lab Consultants are helpful
     • Some warranties require consultation when re-ordering

Scleral Lens Handling

Insertion
   - Prepare Lens
     • Large DMV
     • Clean lens, rinse
   - Fill with non-preserved sol
     • 0.9% NaCl inhalation sol
     • Off label: Addipak, Modudose
     • Lacripure, ScleralFil (buffered)
     • Refresh Optive single vials
     • Celluvisc

Is buffered better??

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Current accepted pH range of 6.60 to 7.80 for ocular comfort
Fitting Basics
Lens Insertion
• Place paper towels on patient’s lap
• Have patient tuck chin to chest and look straight down
• Have patient hold lower lid
• Clinician hold upper lid
• Insert lens straight onto cornea

Fitting Basics
Scleral Lens Handling
• Removal
  – Loosen Lens – gently nudge lens
  – Medium DMV
    • placed on inferior portion of lens
  – Hold both lids

Fitting Basics
Lens Application

Fitting Basics
Lens Removal

Fitting Basics
Scleral Lens Handling

UMSL Optometry
Fitting Basics
Scleral Lens Handling
• Educate patient about proper lens orientation upon insertion
  – Dots at 6 o’clock

Parameter Considerations
• Common Parameter Changes:
  – Sagittal Height
  – Overall diameter (OAD)
  – Optic Zone Diameter (OZD)
  – Base Curve (BC)
  – PC width
  – PC radius of curvature
  – Center Thickness

Parameter Considerations
• Common Parameter Changes:
  – Sagittal Height
  • Adjustment to the transition zone
  • Allows clinician to increase or decrease central lens clearance without adjusting base curve or peripheral lens curves
  • Indicate to lab the amount of clearance you want to gain or lose

Patient GH
• New Scleral Lens
  • OD: 7.5 / 14.8 / -7.50 / -1.25 x 013 20/30
  – 1 step steep limbal zone
  • OS: 7.18 / 14.8 / -8.25 / -0.75 x 162 20/40+
  – 1 step flat limbal zone; 1 step flat scleral zone

Patient GH
• Fit in 2013
• OD: 7.50 / -7.00 / 14.5 20/50
• OS: 7.5 / -7.50 / 14.5 20/40
• SLE: central touch in both eyes
  • Increase diameter; increase sagittal height; steepen lens

Parameter Considerations
• Common Parameter Changes:
  – Overall diameter (OAD) / Optic Zone Diameter (OZD)
  • Can increase or decrease
    – More likely to increase
  • If you need additional central clearance
    – Can increase OZD which will increase OAD
  • If you need more clearance at limbus
    – Can increase OZD which will increase OAD
Parameter Considerations

- **OZD changes:** often done to improve fit
  - **OZD increase without BC compensation**
    
    ![Diagram showing OZD: 8.2 mm BC: 7.5 mm](OZD_8.2mm_BC_7.5mm.png)
    
    Sag: 1.2 mm
    ▲ 300 mic
    Sag: 1.5 mm

- **Increase OZD with BC compensation**
  
  ![Diagram showing OZD: 9.0 mm BC: 8.25 mm](OZD_9.0mm_BC_8.25mm.png)
  
  Sag: 1.2 mm
  ▲ 0 mic
  Sag: 1.2 mm

  * Increased OZD without increasing sagittal height of lens

Parameter Considerations

- **Common Parameter Changes:**
  - **Base Curve (BC)**
    - Typically adjusted during initial fit
    - Flatter base curve to address peripheral lens tightness or excessive central clearance
    - Steeper base curve to increase central clearance or loose periphery
    - If you need to adjust the central clearance, but you are happy with peripheral alignment
      - Adjust sagittal height NOT base curve

Parameter Considerations

- **PC width / PC radius of curvature**
  - Make wider or smaller
  - Steeper or flatter
  - Toric Haptics

- **Center Thickness**
  - Can increase or decrease
    - Considerations: flexure and edema

Parameter Considerations

- **Scleral Curve Changes**
  
  ![Diagram showing Steeper PCs and Flatter PCs](Scleral_Curve.png)
  
  Steeper PCs
  ▲ 100 mic
  Flatter PCs
  Sag: 2.8 mm
  Sag: 2.7 mm

Tips for Fitting

- **1. Go flatter than flat K value for initial lens selection**
- **2. Use Fluorescein for initial lens selection**
  - Use BLUE Light – GET THE BIG PICTURE
  - Use WHITE Light – to evaluate everything else
- **3. Analyze Superior and Inferior lens edges in Primary Gaze**
- **4. Try not to make parameter changes at dispensing**
- **5. Toric Haptics – spin lens and watch for quick return**
Tips for Follow-up

• 1. Ask patient: “How do you take care of your lenses”
• 2. Follow-up should be at least 2 hours after lens insertion
• 3. Paint the front of the lens to look for fluid exchange
• 4. Remove lens and evaluate cornea

Troubleshooting

• Problem: Decreased vision after insertion
  – Often caused by mucin build-up in tear lens
  – Begins ~30min to 4 hrs after insertion

• Possible Solutions
  – Reinsert lens with fresh solution/ use solution mixture
  – Rx lid hygiene
  – Rinse eye prior to insertion
  – Refit with decreased central clearance/better peripheral alignment
  – Change lens material or Lens coating – Hydra-PEG

Troubleshooting

• Decreased Vision after Insertion
  Patient states vision gets foggy after 2 hours of wear and gradual decreases in clarity over time
  ~200 microns clearance OD/OS
  NaFL seeps under lens superiorly OD and 360 OS
  Re-order: steeper PC OU

Troubleshooting

Conjunctival Prolapse
  – Caused by negative pressure under the lens
  – More prominent in patients with loose conjunctival tissue or elderly patients
  • Check for neovascularization
  • Solution
    – 1. Fit a asymmetrical back surface scleral lens to help alleviate the problem
    – 2. Decrease limbal clearance

Troubleshooting

• Conjunctival Prolapse
  – Prolapse with tight PC
    – Flatten the PC
Troubleshooting

Conjunctival Prolapse

- Prolapse with peripheral alignment
  - Decrease the limbal clearance
  - 2 ways:
    - Flatten the BC
    - Decrease the reverse curve

A severe case of stain

- 27 yo patient with Keratoconus OU
  - Wearing scleral lens OU – 2014
  - Hx of Corneal Crosslinking OU (’09)
- Presents 7/2017
  - Cc: blurred vision OS> OD
  - using clear care to clean lenses
  - sometimes sleeps in lenses
  - uses Boston Advance to fill lenses prior to insertion

Troubleshooting

- Problem: Diffuse Corneal Staining on follow-up
  - Due to fill media, care systems, R7’s or meds
  - Can be difficult to isolate cause
  - Can be more significant if tear exchange is low

  Possible solutions:
  - Switch Care systems
  - Rx 0.9%NaCl inhalation solution
  - Completely rinse MPS off lens
  - Confirm compliance with prescribed care

A severe case of stain

- 27 yo patient with Keratoconus OU
  - VA 20/30 OD 20/125 OS
  - SLE: Punctate staining OU, mild corneal edema OS
  - 150 microns clearance OU
  - Adequate limbal clearance
  - No peripheral blanching or impingement

  Plan: educated patient about proper lens care; RTC 1 week fitting

Troubleshooting

- Problem: Poor surface wetting
  - MGD can contribute / cause problem
  - Multipurpose Solution (MPS) may cause problems
  - Lens Material

  Possible Solutions:
  - Evaluate lid margins/ tear film
  - Prescribe lid hygiene if necessary
  - Change MPS / Lens material
  - Lens Coating – hydra-PEG

39 yo female
PKP OD / KCN OS
Jupiter scleral OU – Tyrop 97
Issues with surface wettability

Re-order OU with hydra-PEG
Patient LOVES hydra-PEG – has significantly decreased surface deposits and she does not have to remove to clean during the day.

Troubleshooting

- Problem: Poor surface wetting (old lens)
  - Lens Coating break-down
  - Lens Material break-down

  Possible Solutions:
  - Order new lenses (with HydraPEG)
  - Clean with laboratory cleaner
  - Prescribe Progent
Troubleshooting

Case TS: KCN and Fuchs

- Keratoconus and Fuchs! Oh My!
- 64 you Female with Keratoconus
  - Presents with blurry vision in scleral lenses and irritation OU
  - Lenses are uncomfortable and dry
  - Redness OU
- Interested in Eyeprint PRO
- 20/40 - OD
- 20/30 - OS
- HVID 12mm
- OD: +0.75 -4.00 x 175 20/40–
- OS: +1.50 -3.50 x 180 20/40–
- Pinguecula Temporal and Nasal OU

Possible Solutions:
- Prevention: do endothelial cell count before fitting (1000 +?)
- Educate graft patients on symptoms of rejection: pain, light sensitivity, redness, blurred vision
- Consider Dk/L as Dk is likely not the issue
- More common in post PK corneas
- Can arise after weeks / months => f/u is important!
- Options to Troubleshoot Pinguecula:
  - Microvault
  - Toric PC

Case TS: KCN and Fuchs

- Initial FITTING
- HVID 12mm; Pinguecula T/N OU
  - 8.4 base curve 4.6 sagittal height 17.0 diameter
  - OR: +3.75 -0.75 x 180 20/25–
  - +4.00 -0.75 x 180 20/30
- Options to Troubleshoot Pinguecula:
  - Microvault
  - Toric PC
Case TS: KCN and Fuchs

- Toric Haptics/Peripheral Curves
  - Steepen the Vertical meridian to relieve pressure in the horizontal
  - Flatten the horizontal meridian
  - Always evaluate the location of the flat meridian markings

- MicroVault
  - Confirm lens design can incorporate microvaul ts
  - Measure location and size

Troubleshooting

• Problem: Discomfort immediately after insertion
  - Ask patient where discomfort is located
  - Poor peripheral fit – too flat
  - Base curve too flat - central bearing or touch
  - Mucus adhered to back surface of lens

• Possible solutions:
  - Adjust peripheral systems for proper alignment
  - Select steeper base curve
  - Clean inside of bowl daily; prescribe Progent (Menicon) to remove mucus

Troubleshooting

• Problem: Discomfort after several hours of wear
  - Follow-up patient questions
  - Does your eye become red while wearing the lens?
  - Does your eye become red after lens removal?
  - Where is the irritation located?
  - Do you notice any changes in your vision?
  - What solution(s) are you using for lens application?

• Problem: Discomfort after several hours of wear
  - Poor peripheral fit (too steep)
  - Lens is too small to support its weight
  - Corneal chamber too small

• Possible solutions:
  - Adjust peripheral systems for proper alignment
  - Increase surface area of scleral curves
  - Increase OAD or corneal chamber size if appropriate

Troubleshooting

• Problem: Discomfort after several hours of wear
  - Poor peripheral fit – scleral compression
  - Causing rebound hyperemia and inflammation

• Possible solutions:
  - Changing Diameter
  - Changing peripheral curves

Troubleshooting

• Problem: Bubbles under the lens
  - Too much sagittal height/Too flat peripheral curves
  - Improper insertion
  - Fenestration hole

• Possible Solutions:
  - Fill bowl completely with solution prior to insertion
  - Remove fenestration hole
  - Central bubble: Adjust lens parameters to decrease sagittal height
  - Peripheral bubbles: steepen peripheral curves or increase lens diameter
Patient AB

- History: KCN OU; crosslinking OU
- Lens history: soft toric lenses

Patient AB

- Examination findings
  - MR:
    - OD +0.75 -3.50 x 060  20/70+
    - OS -0.25 -0.75 x 142  20/100+
  - Lens options
    - Specialty Corneal lens
      - Patient attempted to wear and could not adapt
    - Intralimb design
      - Patient attempted to wear and could not adapt
    - Scleral Lens

Final Thoughts

- Consider mini-scleral / scleral for appropriate patients
  - Select one lab, one design
- First couple fits are the most challenging
- Scleral lenses are not going away
- Consultants are a great resource
- Huge practice building opportunity